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INVESTIGATION OF A TOWLINE WITH SEGMENTED FAIRING FOR THE VARIA--ETC(U)
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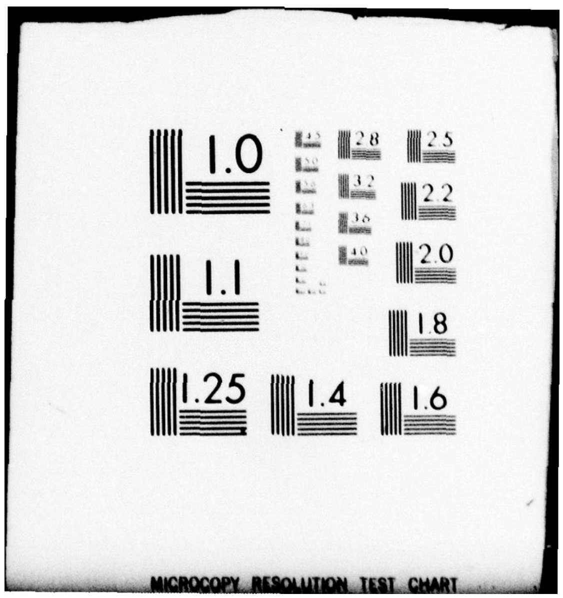
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NAVAL SHIP RESEARCH AND DEVELOPMENT CENTER

Washington, D.C. 20034

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(6) INVESTIGATION OF A TOWLINE WITH SEGMENTED FAIRING FOR THE VARIABLE DEPTH SONAR SYSTEM.

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by

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(12) 12p.

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Naval Ship Research and Development Center
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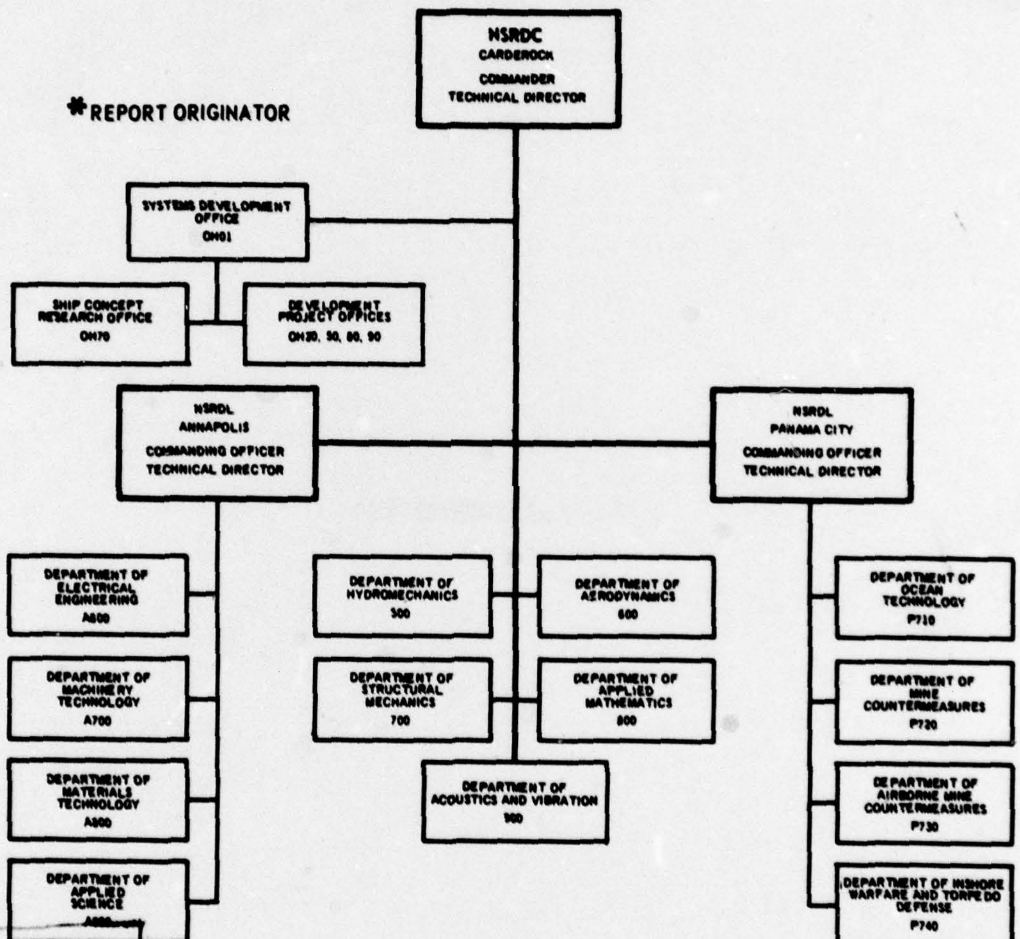

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ADMINISTRATIVE INFORMATION

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INTRODUCTION

The Naval Ship Research and Development Center has established a continuing research program directed toward improving the Variable Depth Sonar (VDS) system. One major area of concern is the system towline. The VDS system has been plagued with problems of towline kiting and fairing breakage caused by the hydromechanic forces acting on the towline during towing and reeling operations. The problem has been present with both sectional enclosed and continuous trailing fairing. → to pg 6

A component of the hydromechanic force acts longitudinally along the cable during towing. In the case of sectional enclosed fairing, which is the type of fairing now being used in the fleet, this component of the force causes the fairing to stack progressively tighter down the cable. This stacking can cause the fairing sections to bind and not aline with the flow, thus creating a side force on the towline causing the towline to kite. The force on the sections near the lower end of the towline is often large enough to damage the fairing sections.

In the case of the continuous trailing fairing the component of force along the fairing causes the fairing to stretch putting the fairing in tension near the ship and in compression near the towed body. When

the force becomes large enough, the fairing in compression will buckle causing asymmetric side forces. These side forces can cause the fairing to kite and buckling will increase the drag.

These problems create a need to transfer the longitudinal load from the fairing to the cable at discrete locations while still allowing the fairing to swivel. The Center designed a device to transfer these forces to the cable. This device is the DTMB Mark I Cable Fairing Restrainer[1] which was tested on a continuous trailing fairing. The results showed that the concept of restraining rings was feasible but the continuous fairing still presented some problems.

The concept of segmented trailing fairing has been tested on small cables up to 0.75-inch in diameter but until now has not been tested on cables of the size presently being used in the VDS program. Thus, the Center proposed that the continuous trailing fairing be cut into segments with a restrainer ring at the upper end of each segment and a space being left between segments to allow for stretch of the fairing. A towline was constructed with segmented trailing fairing on a 1.345-inch diameter cable. This towline was tested at sea on USS BORIE (DD 704) to insure adequate towing performance could be achieved (no kiting). This report describes the towline and the sea trial procedure, presents the results of the trials, and draws conclusions pertaining to the successful use of this concept.

DESCRIPTION OF EQUIPMENT

A standard fleet AN/SQA-10 VDS towline, which provides the mechanical support to tow the SQA-10 body and contains the conductors for transmitting

[1]References are listed on page 10

electrical signals between the ship and the body, was modified by installing segmented trailing fairing to replace the original sectional enclosed fairing. A segment of the modified towline consists of towcable, headpiece, trailing fairing segment and clips, as shown in Figure 1. The towcable is a 565-foot length of 1.345-inch-diameter, double-armored cable with 67 electrical conductors. The standard towcable is a 600-foot length of the same cable.

The trailing segment consisted of an ozone and weather resistant butyl rubber[2]. The fairing had a total length of approximately 400 feet in 13-foot 4-inch segments with a section shape of NSRDC T-5 fairing. The offsets of the fairing mold are given in Table 1. The fairing deviated from this shape by amounts consistant with normal amounts of shrinkage. Hydrostatic stability is achieved by having the trailing edge of the fairing lighter than the leading edge, and structural stability is improved by the trailing edge having a lower modulus of elasticity than the leading edge.

The restraining rings were bonded to the towline. A stainless steel headpiece was attached to the cable around the restraining ring so that the headpiece could swivel but could not move longitudinally along the cable*. The upper end of the fairing segment was attached to the headpiece and the remaining part of the segment was attached to the cable with fairing clips placed approximately 8 inches apart. This arrangement allows the fairing freedom to swivel and except for the upper end to move longitudinally along the cable during reeling or as the fairing stretches during towing. A gap of 4 inches is provided between the end of one segment and the headpiece of the next when the fairing segment is in an unstretched

*A split nylon bearing ring was put on each side of the restraining ring to serve as a bearing surface.

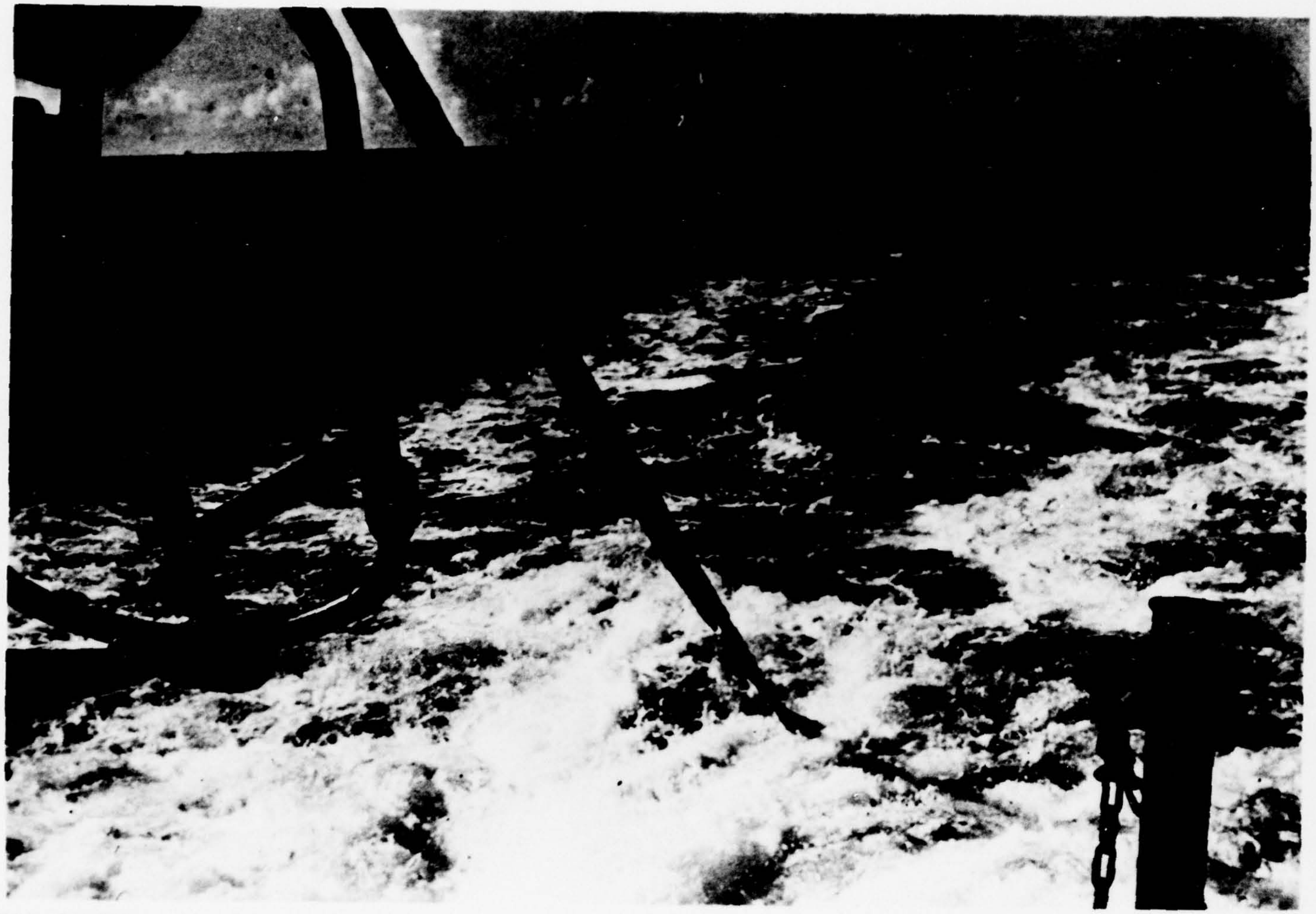

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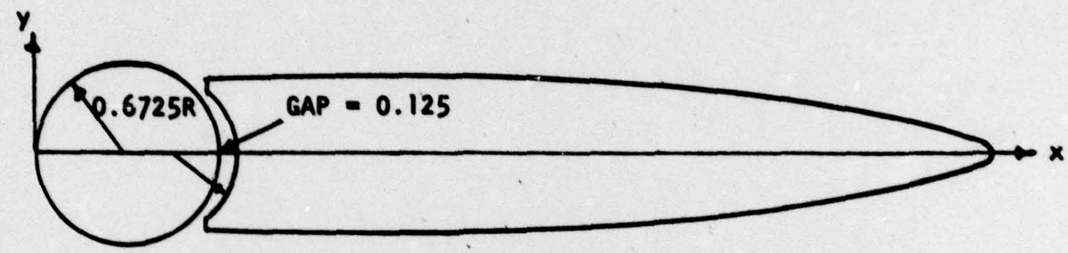
Figure 1 - Segmented Towline Entering The Water During Sea Trials

TABLE 1

Dimensional Offsets of Mold for T-5 Fairing for a 1.345-inch-diameter Cable



x in inches	± y in inches
1.293	0.5625
2.629	0.5625
3.079	0.5621
3.529	0.5590
3.979	0.5505
4.429	0.5344
4.879	0.5075
5.329	0.4677
5.779	0.4120
6.229	0.3376
6.455	0.2921
6.679	0.2387
6.905	0.1690
7.017	0.1194
7.037	0.0780 Radius
7.129	0

condition. The arrangement of the headpiece, restraining ring, bearing, fairing segment, and clips are shown in Figures 2 and 3. Further details about the towline are given in Reference 2.

SEA TRIAL PROCEDURE

The sea trial was directed toward determining whether the towline would kite during towing operation and determining the durability of the new material in the towline. A limited length of time was available to test the towline. The objective and the time available determined the following sea trial procedure.

The towline was reeled onto a standard AN/SQA-10 winch although this system is not designed to be used with segmented fairing. The lower end of the towline was attached to the standard AN/SQA-10 towed body which has instrumentation to measure roll and pitch. The towed body was put into the water with 45 feet of towline in the water. The body was towed at 10 and 15 knots to insure that the body was in proper trim and that any irregularities in body performance with a longer towline would be due to the towline and not due to the body. Body roll and pitch and towline kite were monitored for all runs.

The body was first towed with the ship on a straight course at speeds of 10, 15 and 18 knots and with cable scopes of 100, 200, 300, 400 and 465 feet although only the first 400 feet was faired. All scopes were measured from the water line at 10 knots. The amount of cable in the water varied slightly as speed was increased.

After insuring that the body towed in a straight path, it was planned to repeat all runs with turns, however, after making standard 180

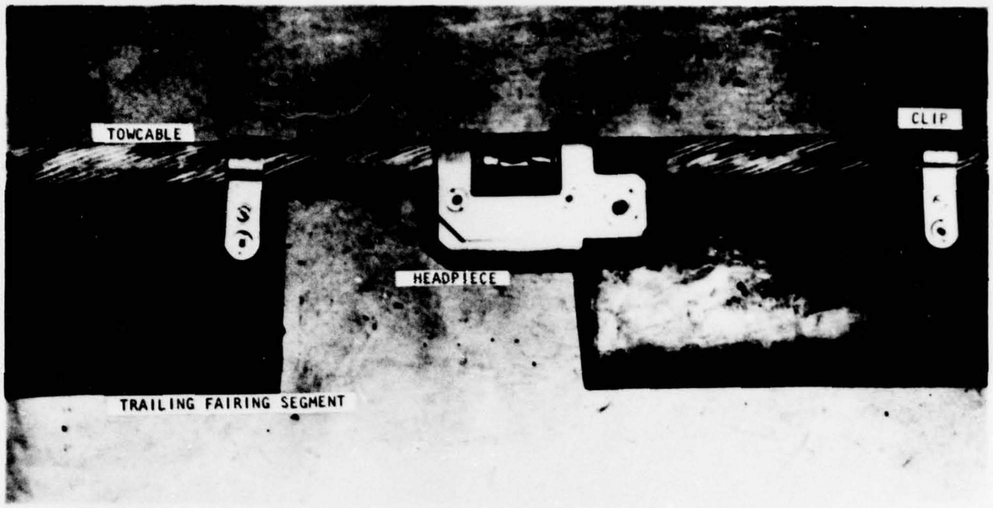


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Figure 2 - Arrangement of Cable, Fairing Segment, Headpiece, Restraining Ring and Clips

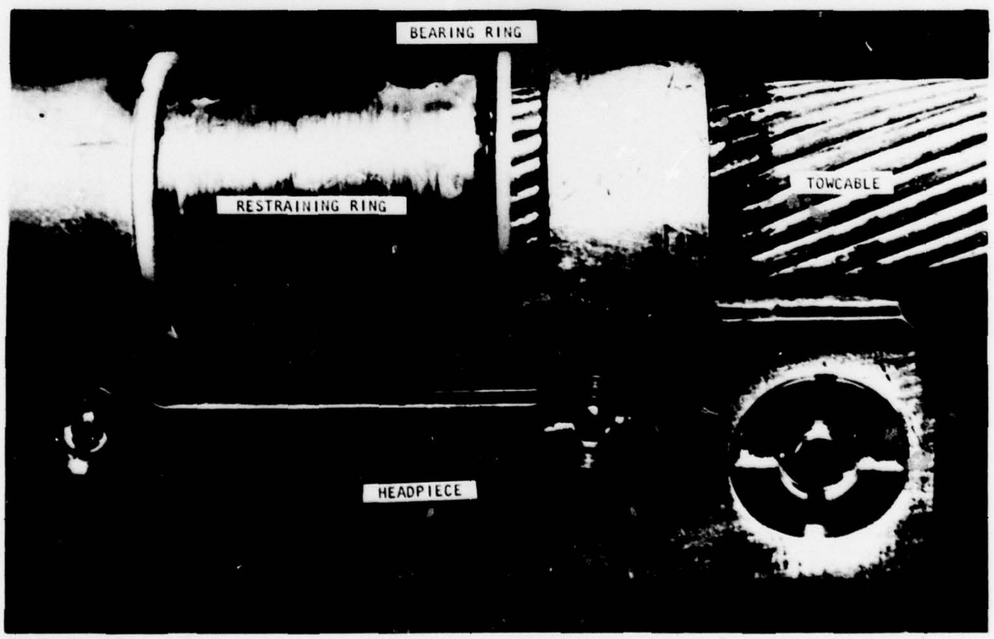

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Figure 3 - Headpiece, Restraining Ring And Nylon Bearing Rings

degree turns at 10, 15 and 18 knots with scopes of 100 and 200 feet a hydraulic line broke while reeling out from 200 to 300 feet of cable. The hydraulic line was repaired but it was not certain if the original problem of the winch which caused the failure had been repaired. Due to the winch uncertainties and the delay, it was decided to delete any remaining turning tests and proceed with the endurance test which also would include more turns.

The cable was paid out to 400 feet and the speed was increased to 25 knots. After towing on a straight course the ship made several minimum radius turns to both port and starboard. The ship continued at 25 knots for the remainder of the allowable time. The total time towing the system at 25 knots was 5 1/4 hours. The total towing time for the tests was 13 hours.

At the conclusion of the test the towline was examined for damage.

SEA TRIAL RESULTS

Throughout the test the body showed no unusual roll or pitch tendencies. The roll was 0 ±0.5 degree and the pitch was 1.0 ±0.5 degree for all cases when the ship was traveling on a straight course. The roll and pitch varied as much as 5 degrees during turns but always returned when the ship returned to the straight course.

Towline kite angle, the angle between the towline and the vertical as projected on a vertical plane normal to the ship centerline, could only be measured to ±2 degrees. The kite angle never varied more than ±5 degrees during straight towing, including after straightening from a turn as shown in Reference 3.

The damage to the towline consisted of bent clips and nylon bearing

rings which had separated from the towcable. The clips bent during reeling operations. It could not be determined whether the nylon rings came off due entirely to hydrodynamic forces or if they become weakened due to forces present when reeling in and out. The butyl rubber trailing fairing showed no damage due to the hydrodynamic forces developed while towing at 25 knots.

CONCLUSIONS

Based on the data obtained and observations of the towing, the following conclusions are drawn about the towing performance of the towline:

1. The T-5 shape trailing fairing on a 1.345-inch diameter cable is hydrodynamically stable.

2. The towline does not kite. The towline enters the water directly astern of the ship (within 5 degrees when measured from the vertical) when towed on a straight course.

3. Although the towline gives the appearance of kiting during turns, it always returns to directly astern of the ship when the ship returns to a straight course.

Based on observations made of the towline after the towing trials, the following conclusions can be drawn about the towline material:

4. Butyl rubber is a satisfactory material for the trailing segments of the fairing. The material showed no distortion from the stretching during high speed towing or from the reeling and storage on a circular drum.

5. The clips were bent due to reeling operations. This damage can be avoided with a properly designed winch system.

6. The nylon bearing rings did not stay in place and should be attached in a positive manner, or eliminated if it can be shown that they are not necessary.

REFERENCES

1. Brisbane, A. P., "The DTMB Mark I Cable-Fairing Restrainer", David Taylor Model Basin Report 2009 (May 1965)

2. Chatten, C. K., "Development of Butyl-Rubber Fairing for Variable Depth Sonar Towcables", Naval Ship Research and Development Center Report 8-961 (November 1971)

3. Naval Ship Research and Development Center Film Report M-2325, "An At-Sea Evaluation of An Experimental VDS Towline" (August 1971)